Gastrointest Interv 2014; 3:46–53

Contents lists available at ScienceDirect

Gastrointestinal Intervention

journal homepage: www.gi-intervention.org

Original Article

Endovascular management of pancreatitis related pseudoaneurysms – A single center experience

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A B S T R A C T

Background: To retrospectively analyze the imaging characteristics, techniques, and outcome in patients who underwent endovascular treatment for pancreatitis-related pseudoaneurysms.

Methods: The study included 38 patients with pancreatitis who had pseudoaneurysm as a complication and who had been treated by endovascular methods between 2000 and 2013. Of the 38 patients, 24 (male:female = 21:3; average age 41.5 years) had imaging features of chronic pancreatitis. Fourteen patients (male:female = 12:2; average age 54.9 years) had features of acute pancreatitis. Computed tomography and digital subtraction angiography features of the pseudoaneurysms, endovascular technique and outcome in these patients were analyzed.

Results: The average size of pseudoaneurysms in patients with acute pancreatitis was 24.2 mm and 24.7 mm in those with chronic pancreatitis. No statistically significant ($P = 0.913$) difference in size was noted. Pseudoaneurysms in patients with chronic pancreatitis had more well-defined and thicker walls (average wall thickness 18.1 mm). Coil embolization was performed in 26 patients (68.4%). *N*-butyl cyanoacrylate embolization was done in five patients (13.1%). A covered stent was used in one patient (2.6%). A combination of techniques was used in five patients (13.1%) and gelfoam embolization alone was performed in one patient (2.6%). Technical success was achieved in 37 patients (97.3%). Reintervention was done in one patient. The mean imaging follow-up time was 10.74 months (3 days–84 months) and was available in 35 patients (92.1%). One patient died because of sepsis related to pancreatitis.

Conclusion: Endovascular treatment is an effective first line of management in pancreatic pseudoaneurysms. The endovascular technique depends on the vascular location and morphological features of the pseudoaneurysm.

Keywords: computed tomography, digital subtraction angiography, embolization, pancreatitis, pseudoaneurysms

Introduction

The occurrence of vascular complications in the form of pseudoaneurysm of visceral arteries is reported to range from 1.2% to 14% with a higher incidence in chronic pancreatitis (7–10%) than in acute pancreatitis (1–6%).[1,2] Pseudoaneurysms can cause lethal hemorrhage and the mortality in untreated patients can be as high as 90%.[3] Hence it becomes important to recognize and treat these patients as early as possible irrespective of the size of the pseudoaneurysm and patient's symptoms. Endovascular techniques with success rates of 79–100% have replaced surgery as the first line of management in these patients.[4,5] Because of the low overall incidence of pseudoaneurysms and the need to achieve rapid hemostasis, randomized control trials of therapeutic options are not possible.

The published data regarding pancreatitis-related pseudoaneurysms is limited to review articles and short case series. The largest published study is of 104 cases in which endovascular embolization was performed in 32 patients.[6] To best of our knowledge, this present study is the largest single-center series of pancreatitis-related pseudoaneurysms treated by endovascular methods. The purpose of the study was to retrospectively analyze the imaging characteristics, techniques and outcome in patients presenting with pancreatitis-related pseudoaneurysms who underwent endovascular treatments. The study also aims to compare the morphological features of pseudoaneurysms in acute and chronic pancreatitis to identify features which may impact the endovascular technique.

Methods

Patient population

Institutional review board approval was obtained for this retrospective analysis. We retrieved the hospital records of 1150

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Received 15 December 2013; Revised 24 February 2014; Accepted 28 February 2014
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http://dx.doi.org/10.1016/j.gii.2014.02.003

patients with pancreatitis and identified 38 patients (3.3%) with pseudoaneurysm as a complication and treated by endovascular methods between 2000 and 2013. Clinical records and images were retrieved from electronic medical records and picture archiving and communication systems.

Of the total 38 patients, 24 (male:female = 21:3) had background imaging features of chronic pancreatitis and ranged in age from 15 years to 84 years (mean ± SD = 41.5 ± 17.5). Of these 24 patients, 6 (25%) were ≤30years. Fourteen patients (M:F = 12:2) had features of only acute pancreatitis and ranged in age from 34 years to 73 years (mean ± SD = 54.9 ± 10.5). The majority of patients (16/24; 66.6%) with a background of chronic pancreatitis presented with evidence of gastrointestinal bleeding, six (25%) presented with only acute abdominal pain and two (8.3%) had no symptoms. The majority of patients with acute pancreatitis presented with only acute pain abdomen (10/14; 71.4%) whereas four (28.5%) presented with evidence of gastrointestinal bleeding.

Imaging and intervention technique

In the period 2000–2005, our patients were imaged with single slice spiral computed tomography (CT). From 2005 onwards we had used 64-slice CT to perform triple phase CT prior to the procedure in all patients. Initial plain CT of upper abdomen was done to identify calcifications or hematoma and subsequently contrast-enhanced images were obtained in the arterial phase and venous phase. Presence of parenchymal atrophy, duct dilatation, parenchymal calcification or intraductal calculi on CT were considered as features of chronic pancreatitis[7] (Fig. 1). Tropical pancreatitis was diagnosed in young patients (<30 years) with typical imaging and clinical features.[5,6]

Digital subtraction angiography (DSA) was performed through femoral artery access in all patients using a 5F Simmons 1 or Chuang 2 catheter (Cook, Bloomington, IN, USA). Superselective catheterization was achieved with a coaxially introduced 3F microcatheter (Progreat, Terumo, Tokyo, Japan or Microferret, Cook, Blomington, IN, USA) and embolization performed with pushable steel coils (Tornado, Cook), *N*-butyl cyanoacrylate (NBCA, lipiodol and NBCA mixture of 15–20%) or gelfoam. The coaxial technique was used in all patients. In one patient a large pseudoaneurysm arising from the superior mesenteric artery (SMA) trunk was successfully treated by deploying a covered stent (Gore, Viabahn, Flagstaff, AZ, USA) from a brachial approach. Percutaneous injection of NBCA was done using Chiba needle (Cook, Bloomington, IN, USA) under ultrasound guidance.

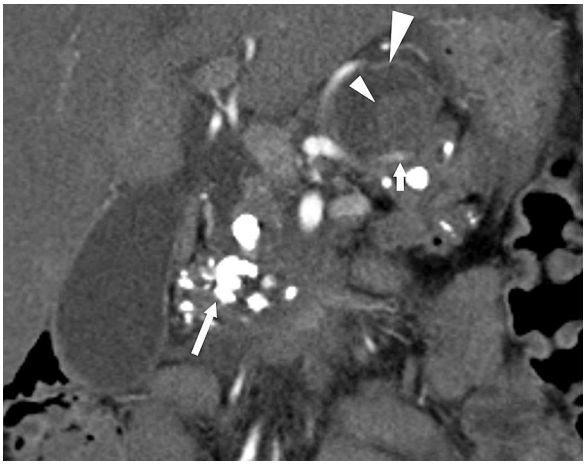

Fig. 1. A 40-year-old female with chronic calcific pancreatitis presented with hematemesis. Contrast-enhanced computed tomography shows multiple intraductal and intraparenchymal calcifications in the head region (white arrow). Pseudocyst (large arrowhead) in tail region with hyperdense content within, suggestive of clot (small arrowhead). Note splenic artery (small arrow) traversing through the inferior wall of the pseudocyst. Digital subtraction angiography (not shown) confirmed a rent in the splenic artery which was treated by coil trapping.

Analysis

Primary end points: (1) technical success, defined as successful exclusion of pseudoaneurysm from systemic circulation, confirmed by DSA at end of procedure; (2) target lesion reintervention was defined as requiring an additional procedure (surgical or percutaneous) due to reperfusion of pseudoaneurysm; and (3) periprocedural mortality was defined as death occurring within 1 month of the procedure. Secondary end points were major or minor complications defined as per international reporting standards.[8]

Follow-up imaging was done with either a Doppler study, contrast enhanced CT or DSA. Statistical analysis was performed using IBM SPSS Statistics 20.0 software. The data were analyzed using descriptive statistical methods. Comparison between groups was done using the Mann–Whitney *U* test and Wilcoxon signed-rank test.

Results

Morphological features of pseudoaneurysms

The site of origin of pseudoaneurysms in acute pancreatitis and in patients with background chronic pancreatitis is shown in Table 1. In both groups the splenic artery (SA) was the most common artery of origin. The average size of the pseudoaneurysm in acute pancreatitis patients as measured using CT was 4–43 mm (24.2 ± 13.8 mm) and in patients with background chronic pancreatitis was 2–50 mm (24.7 ± 13.8 mm). Comparing sizes of pseudoaneurysms in acute and background chronic pancreatitis patients using the Mann-Whitney *U* test, showed no statistically significant ($P = 0.913$) difference in size of pseudoaneurysms between the two groups.

We also noticed that a large proportion of pseudoaneurysms (12/24; 50%) in patients with background chronic pancreatitis had thicker walls (average wall thickness 18.1 mm), whereas in acute pancreatitis, pseudoaneurysms had imperceptible walls. The average size of pseudoaneurysm in these 12 patients as measured using CT was 36.3 ± 6.3 mm and 18.2 ± 3.3 mm on DSA. Comparing

Table 1 Artery of Origin in Patients with Acute Pancreatitis and in Patients with Background Chronic Pancreatitis

Patients with acute pancreatitis	
Site of pseudoaneurysm	Number of patients ($n = 14$)
SA	4 (28.5%)
IPDA	4 (28.5%)
GDA	3 (21.4%)
SMA	1 (7.1%)
Jejunal branch of SMA	2 (14.2%)
Patients with background chronic pancreatitis	
Site of pseudoaneurysm	Number of patients ($n = 24$)
SA	11 (45.8%)
GDA	4 (16.6%)
IPDA	3 (12.5%)
CHA	2 (8.3%)
DPA	1 (4.1%)
SPDA	1 (4.1%)
LHA	1 (4.1%)

CHA, common hepatic artery; DPA, dorsal pancreatic artery; GDA, gastroduodenal artery; IPDA, inferior pancreatico duodenal artery; LHA, left hepatic artery; SA, splenic artery; SMA, superior mesenteric artery; SPDA, superior pancreatico duodenal artery.

sizes measured using CT and DSA using the Wilcoxon signed-rank test showed a statistically significant difference ($P = 0.002$).

Treatment technique

Coil embolization was the most common technique used in treating pseudoaneurysms (26/38; 68.4%). Coil trapping, which is isolating the pseudoaneurysm by coil embolization from both ends of the arcade was done in 23 patients. Inflow occlusion was performed in three patients.

NBCA was used when coil trapping was not possible or when there was lack of intra-arterial access either as a result of anatomical location or previous embolization. Percutaneous or transcatheter NBCA injection alone was done in 5/38 (13.1%) and all five patients had background chronic pancreatitis with thick-walled pseudoaneurysms. In four patients [superior pancreatico-duodenal artery (SPDA), left hepatic artery (LHA), splenic artery (SA), gastroduodenal artery (GDA) pseudoaneurysms] NBCA injection was done after achieving a safe microcatheter position either close to or inside the pseudoaneurysm. In a patient with an inferior pancreatico-duodenal artery (IPDA) pseudoaneurysm, an initial attempt to embolize the pseudoaneurysm using NBCA failed as the injected NBCA was shunted into the portal radicals through an arterio-portal fistula. The patient had pre-existing portal cavernoma and the pseudoaneurysm had ruptured into one of the portal collateral channels. The patient was taken for surgery and direct injection of NBCA into the pseudoaneurysm was done intraoperatively under ultrasound guidance. Two-year follow-up ultrasound showed no reperfusion of pseudoaneurysm.

Combination of coiling and transcatheter or percutaneous NBCA embolization was used in 3/38 (7.8%) patients (IPDA, GDA, and SA pseudoaneurysms). In a patient with GDA pseudoaneurysm, after coiling the feeder from the GDA, the pseudoaneurysm continued to fill from tiny branches of the IPDA, which were not suitable for catheterization. Percutaneous injection of NBCA into the pseudoaneurysm was done under ultrasound guidance to complete the treatment. In another patient, after coiling of the main artery, the SA pseudoaneurysm continued to fill from distal small branches of the dorsal pancreatic artery. NBCA was injected into the dorsal pancreatic artery from a relatively proximal position of the microcatheter. Combined coiling and gelfoam embolization was performed in 2/38 (5.2%) patients (IPDA and SA pseudoaneurysms). In one patient (2.6%) a large pseudoaneurysm arising from the SMA trunk was successfully treated by deploying a covered stent across the neck of pseudoaneurysm. Post-procedure the SMA was patent and there was no reperfusion of the pseudoaneurysm (Tables 2, 3).

Technical outcome and complications

The procedural technical success was achieved in 37 of 38 patients (97.3%). In a patient with SA pseudoaneurysm treated with an inflow occlusion technique, the immediate post-procedure DSA showed no perfusion of the pseudoaneurysm. However, 1 month later, CT showed reperfusion of the pseudoaneurysm. No reintervention was attempted because of lack of access to the pseudoaneurysm and patient had to undergo SA ligation and splenectomy.

Procedure-related complications occurred in two patients. In a patient with an IPDA pseudoaneurysm, even though isolation was achieved by coil trapping, one of coils prolapsed in the proper hepatic artery. However, the hepatic artery remained patent (Fig. 2). In another patient with splenic artery pseudoaneurysm treated with intra-arterial NBCA injection, NBCA spilled into distal splenic artery branches leading to a large splenic infarct.

Table 2 Technique of Endovascular Management in Patients with Acute Pancreatitis and in Patients with Background Chronic Pancreatitis

Technique of endovascular management in patients with acute pancreatitis		
Artery of origin	Size (mm)	Technique of embolization
IPDA	4	Coil trapping
IPDA	8.5	Coil trapping and *N*-butyl cyanoacrylate embolization
GDA	5	Coil trapping
IPDA	15	Coil trapping
GDA	40	Inflow occlusion
IPDA	39	Coil trapping and gelfoam embolization
SA	10	Coil trapping and N-butyl cyanoacrylate embolization
SA	22	Coil trapping
SA	30	Coil trapping
Jejunal branch of SMA	30	Gelfoam injection
Jejunal branch of SMA	22	Inflow occlusion
SA	40	Coil trapping and gelfoam embolization.
GDA	43	Coiling and percutaneous *N*-butyl cyanoacrylate injection into pseudoaneurysm
SMA	30	Covered stent
Technique of endovascular management in patients with background chronic pancreatitis		
Artery of origin	Size (mm)	Technique of embolization
IPDA	32	Intra-operative ultrasound guided direct NBCA injection into pseudoaneurysm
SA	36	Coil trapping
SA	15	Coil trapping
DPA	11	Coil trapping
CHA	18	Coil trapping
GDA	2	Coil trapping
SA	20	Coil trapping
GDA	10	Coil trapping
GDA	38	Coil trapping
SA	40	Coil trapping
SPDA	30	Intra-arterial NBCA embolization
SA	36	Coil trapping
SA	18	Coil trapping
SA	6	Coil trapping
SA	28	Coil trapping
SA	2	Coil trapping
Jejunal branch of SMA	29	Coil trapping
SA	45	Inflow occlusion
CHA	24	Coil trapping
LHA	11	Intra-arterial NBCA embolization
IPDA	35	Coil trapping
IPDA	50	Coil trapping
GDA	32	NBCA injection into pseudoaneurysm through microcatheter tip within pseudoaneurysm
SA	20	Intra-arterial NBCA embolization

CHA, common hepatic artery; DPA, dorsal pancreatic artery; GDA, gastroduodenal artery; IPDA, inferior pancreatico duodenal artery; LHA, left hepatic artery; SA, splenic artery; SMA, superior mesenteric artery; SPDA, superior pancreatico duodenal artery.

Table 3 Technique of Endovascular Management

Technique of embolization	Acute pancreatitis ($n = 14$)	Background chronic pancreatitis ($n = 24$)	Total ($n = 38$)
Coil trapping	5	18	23 (60.5%)
Combined coiling and NBCA or gelfoam embolization	5	0	5 (13.1%)
NBCA embolization	0	5	5 (13.1%)
Inflow occlusion	2	1	3 (7.8%)
Covered stent	1	0	1 (2.6%)
Gelfoam embolization	1	0	1 (2.6%)

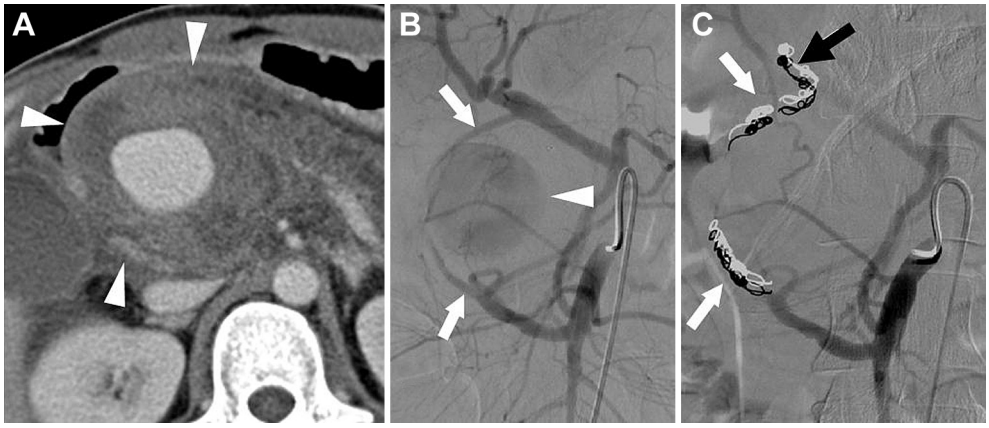

Fig. 2. A 29-year-old male with chronic pancreatitis presented with hematemesis. (A) Contrast-enhanced computed tomography shows a large pseudoaneurysm with peripheral thrombus in the pancreatic head region (arrowheads). (B) Selective digital subtraction angiography shows the pseudoaneurysm (arrowhead) arising from the inferior pancreatico duodenal artery (IPDA) with an additional supply from the GDA (arrows). (C) Feeders from both arteries accessed through the IPDA and coil-embolized (arrows). Complete isolation of the pseudoaneurysm achieved. Note prolapse of one of the coils into proper hepatic artery (C, black arrow); however, the artery is patent.

Follow up

Follow-up imaging was done with either a Doppler study, contrast enhanced CT, or DSA. The postprocedure mean time of follow-up was 10.7 ± 22.5 months (3 days–84 months) and was available in 35 of 38 patients (92.1%). One patient died 15 days after the endovascular procedure. The cause of death was sepsis related to pancreatitis. There were no occurrences of bowel ischemia, hepatic insufficiency, or rupture-related deaths in any of patients in the follow-up period.

Discussion

Pancreatitis is a challenging clinical problem requiring repeated imaging to monitor the progression of disease and to detect the complications. Early detection and prompt treatment of vascular complications is essential because of the high rate of mortality in untreated patients.[3] Recent advances in the MDCT has enabled early detection of vascular complications and provides a clear road map for endovascular therapy. In this study we retrospectively analyzed the imaging characteristics, techniques of endovascular treatment,

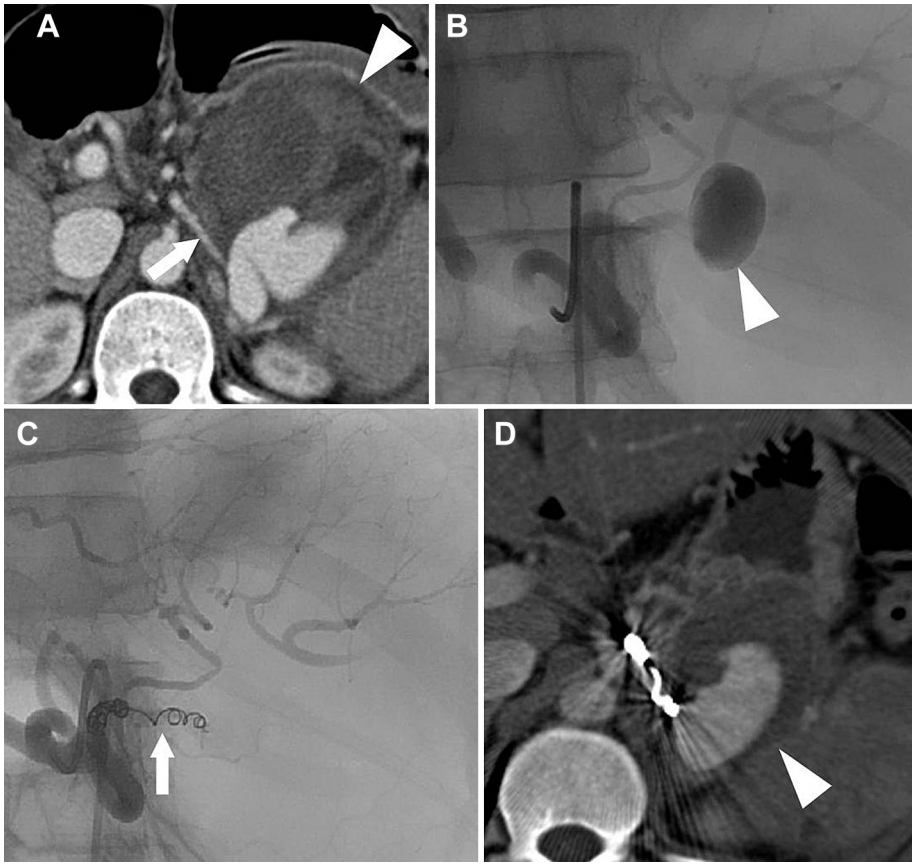

Fig. 3. A 35-year old male with chronic pancreatitis presented with hematemesis. (A) Contrast-enhanced computed tomography (CT) and (B) celiac digital subtraction angiography shows the pseudoaneurysm (B, arrowhead) arising from distal splenic artery (A, arrow). (C) Distal access was not achieved and only the proximal splenic artery was coil-embolized (arrow). (D) Contrast-enhanced CT 1 month later shows reperfusion of the pseudoaneurysm (arrowhead).

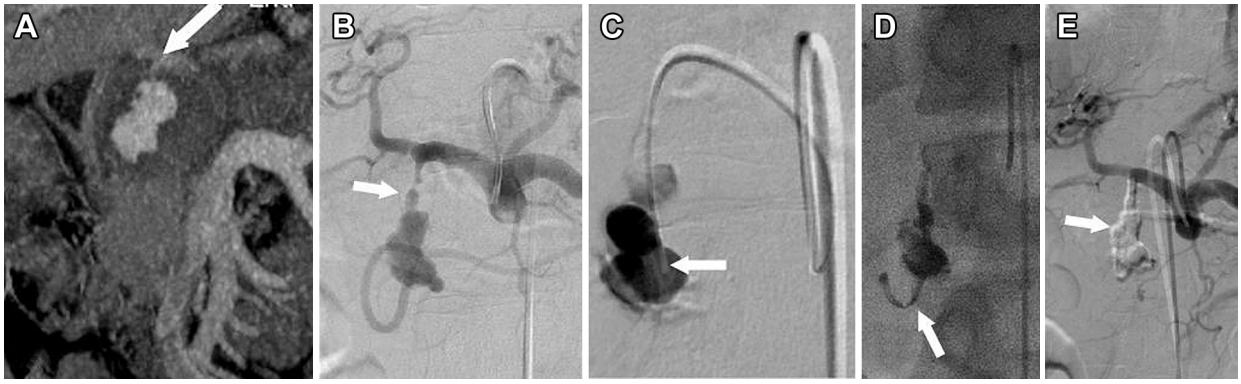

Fig. 4. A 35-year-old male with chronic pancreatitis presented with recurrent abdominal pain. Contrast-enhanced computed tomography and digital subtraction angiography shows the pseudoaneurysm (A, arrow) arising from GDA origin (B, arrow). (C) As distal access was not achieved and there was only a short stump, direct injection of *N*-butyl cyanoacrylate into pseudoaneurysm done with the microcatheter tip positioned within the pseudoaneurysm (arrow). (D) Note the reflux of glue into the distal feeders (arrow). (E) Complete isolation of pseudoaneurysm achieved (arrow).

outcome in patients presenting with pancreatitis-related pseudoaneurysms and also compared the morphological features of pseudoaneurysms in acute and chronic pancreatitis in order to identify features which may impact the endovascular technique.

CT can be performed quickly and has a high reported accuracy in detecting arterial complications.[9] Multidetector computed tomography (MDCT) accurately localizes the pseudoaneurysm and its arterial supply, identifies the difficult angle of origin or an anomalous origin of artery allowing us to draw up a clear strategy for the approach and which embolization technique to use, before the procedure. DSA allows imaging in real time, helping to correctly identify the artery of origin and assess the collateral circulation.[9] Abdominal angiography has been reported to detect the source of bleeding in 94% of patients.[7] We observed that DSA underestimates the size of an pseudoaneurysm with the peripheral thrombus visualizing only the patent lumen whereas CT imaging show the lumen and the peripheral thrombus and thus the actual size of the pseudoaneurysm can be determined. Pseudoaneurysms in pancreatitis are secondary to inflammatory destruction of wall or due to bleeding into the pseudocyst. The wall visible on CT represents only a covering of thrombus, inflammatory, or fibrous tissue. We also noticed that a large proportion of pseudoaneurysms (12/24; 50%) in patients with background chronic pancreatitis had thicker walls (average wall thickness 18.1 mm), whereas in acute pancreatitis, pseudoaneurysms had imperceptible walls (Fig. 2).

We had a unique subset of the population with tropical pancreatitis. Tropical pancreatitis is a unique early onset (<30 years) calcific pancreatitis of unknown etiology prevalent in many tropical countries.[10,11] Kerala, in southern India, where this study was done, has a high prevalence of tropical pancreatitis.[12,13] In our series 25% patients with chronic calcific pancreatitis were <30 years and had no history of alcohol consumption. The early onset of disease, slow progression, and relatively long survival exposes these individuals to the risk of frequent acute exacerbation, vascular complications, and malignancy.

It is common for pseudoaneurysms in the pancreatico-duodenal arcade to fill from both ends of the arcade (gastroduodenal artery and inferior pancreatico-duodenal artery). The goal of treatment is to prevent pseudoaneurysm filling. This is achieved by coiling the feeding arteries. If the pseudoaneurysm fills only from a single artery, coiling of this artery (inflow occlusion) is sufficient. However, trapping the pseudoaneurysm by coiling feeders from both ends of the arcade is usually required. This can be achieved by either

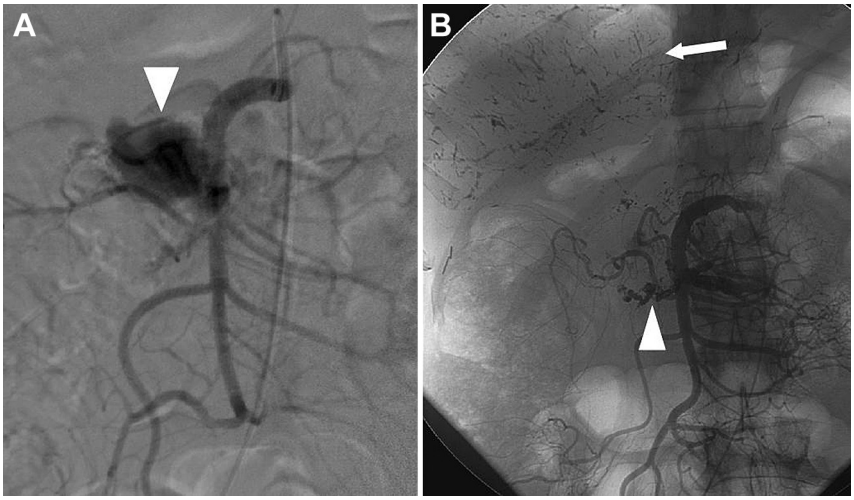

Fig. 5. A 64-year-old male with chronic pancreatitis presented with melaena. (A) Selective digital subtraction angiography (DSA) shows the pseudoaneurysm (arrowhead) arising from the Inferior pancreatico duodenal artery. An initial attempt to embolize with *N*-butyl cyanoacrylate failed because of arterio-portal shunting. Later, embolization was performed intra-operatively by direct injection of *N*-butyl cyanoacrylate into the pseudoaneurysm under ultrasound guidance. (B) DSA following intra-operative embolization shows no reperfusion of pseudoaneurysm (arrowhead). Note glue cast in small intrahepatic portal radicals (arrow).

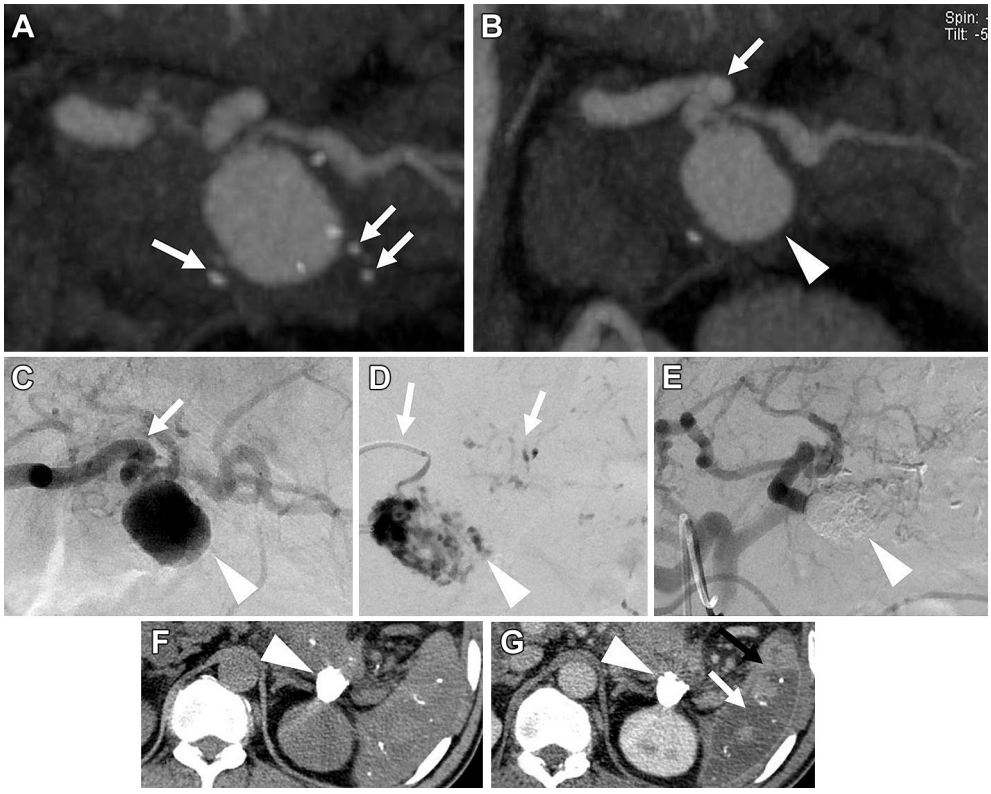

Fig. 6. A 53-year-old male with chronic pancreatitis presented with abdominal pain. Contrast-enhanced computed tomography (CT) and celiac digital subtraction angiography shows multiple intraparenchymal calcifications (A, arrows) and pseudoaneurysm (B,C arrowhead) arising from the distal splenic artery (B,C arrow). (D) As distal access was not achieved, direct intra-arterial *N*-butyl cyanoacrylate injection was performed with the microcatheter tip just proximal to the pseudoaneurysm (arrow). Note spillover of glue into the distal splenic artery branches (small arrow). Post embolization DSA (E) and CT (F) shows glue cast (arrow head). (G) Contrast-enhanced CT 5 days later shows no reperfusion of pseudoaneurysm (arrow head) and multiple splenic infarcts (arrow).

separately accessing the feeding arteries from the gastroduodenal artery (GDA) or superior mesenteric artery (SMA), or by crossing the pseudoaneurysm through the initially accessed feeding artery and then coiling distally. If the feeder from the opposite end of the arcade cannot be accessed, then directly embolizing the pseudoaneurysm intra-arterially with NBCA is an option. Alternatively the accessed feeder can be coiled and subsequently treatment can be completed with direct percutaneous NBCA injection. If the artery of

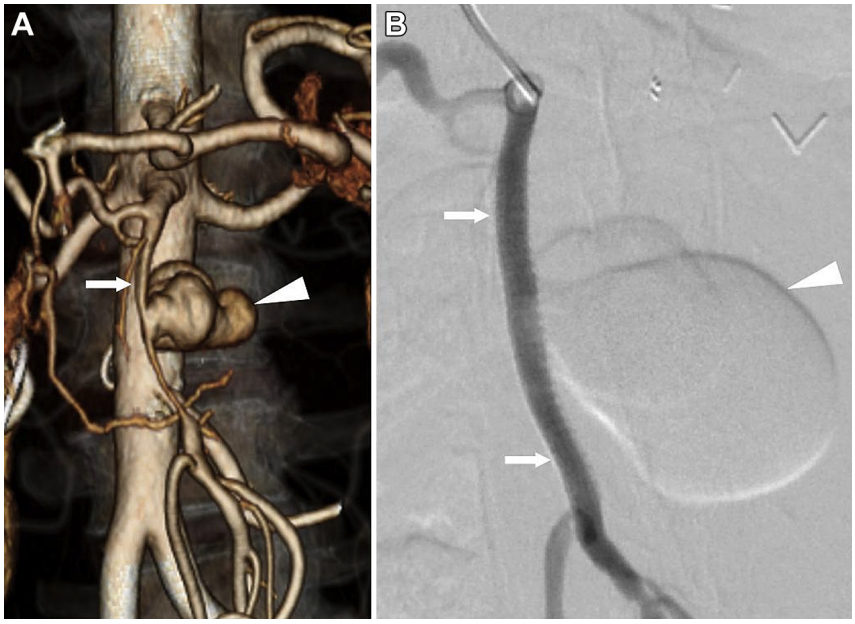

Fig. 7. A 64-year-old male with acute pancreatitis presented with acute abdominal pain. (A) Contrast-enhanced computed tomography coronal volume rendered technique reformatted image showing a pseudoaneurysm (arrowhead) arising from the superior mesenteric artery (SMA, arrow). (B) As the SMA is not expendable, isolation of pseudoaneurysm achieved by deploying a covered stent across the neck of pseudoaneurysm (arrows). Postprocedure the SMA is patent and the pseudoaneurysm completely isolated (arrowhead).

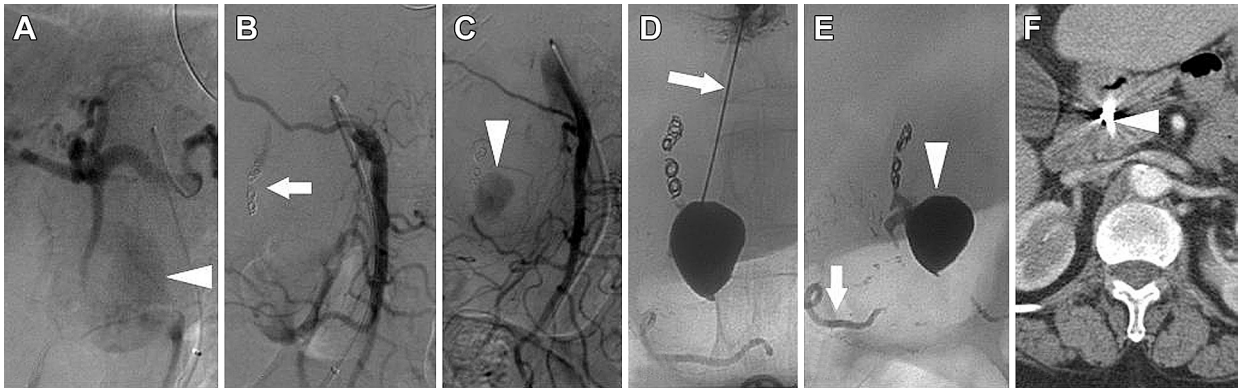

Fig. 8. A 73-year-old female with acute pancreatitis presented with acute pain abdomen. (A) Digital subtraction angiography shows the pseudoaneurysm (arrowhead) arising from the gastroduodenal artery (GDA). (B) Coil embolization of GDA (arrow). (C) However, pseudoaneurysm reperfused through multiple small distal feeders from the pancreaticoduodenal arcade (arrowhead). (D) As these feeders were not accessible, percutaneous direct injection of *N*-butyl cyanoacrylate into the pseudoaneurysm was done under ultrasound guidance using a Chiba needle (D, arrow). (E) Note the reflux of glue into the distal feeders (arrow). (F) Follow-up computed tomography 10 months later showing no reperfusion of the pseudoaneurysm (arrowhead).

origin is not expendable, then the covered stent can be used to exclude the pseudoaneurysms from systemic circulation.

In our study, coil embolization was the commonest technique used to isolate the pseudoaneurysm. The trapping technique achieves complete isolation of pseudoaneurysm by occluding both proximal and distal feeders to the pseudoaneurysm (Fig. 2). Inflow occlusion although technically easy, requires a longer time to produce thrombosis and is associated with a high rate of reperfusion of pseudoaneurysm through distal collaterals (Fig. 3).

Permanent occlusion of pseudoaneurysm can also be achieved using liquid embolic agents such as NBCA or ethylene vinyl alcohol copolymer. Low viscosity of liquid allows it to fill both the pseudoaneurysm and collaterals in a single injection. NBCA can be injected percutaneously under ultrasound guidance or through an appropriately placed microcatheter. Izaki et al,[14] in an analysis of 12 patients of pancreatitis-related pseudoaneurysm, used treatment with NBCA which showed a success of 100%. Intra-arterial or percutaneous NBCA embolization can be done when difficult anatomy precludes coil trapping. Before injecting NBCA it is important to ensure a safe microcatheter position either into or close to the pseudoaneurysm. We used a 15–20% concentration of NBCA which allows filling and complete exclusion of the pseudoaneurysm (Fig. 4, 5). At lower concentrations there is risk of spillage into nontarget distal arteries (Fig. 6). Using a higher concentration carries a risk of premature cast formation and inadequate filling of the pseudoaneurysm which can subsequently reperfuse through distal collaterals. The main concern with using NBCA either intra-arterial or percutaneously is the risk of rupture secondary to increased pressure within the pseudoaneurysm. The percutaneous approach involves puncture through the wall of the pseudoaneurysm which may be especially risky when the wall is friable. We found that a significant number of pseudoaneurysms occurring in a background of chronic pancreatitis had thicker walls. This feature, we believe, could make NBCA injection intra-arterially or percutaneously more

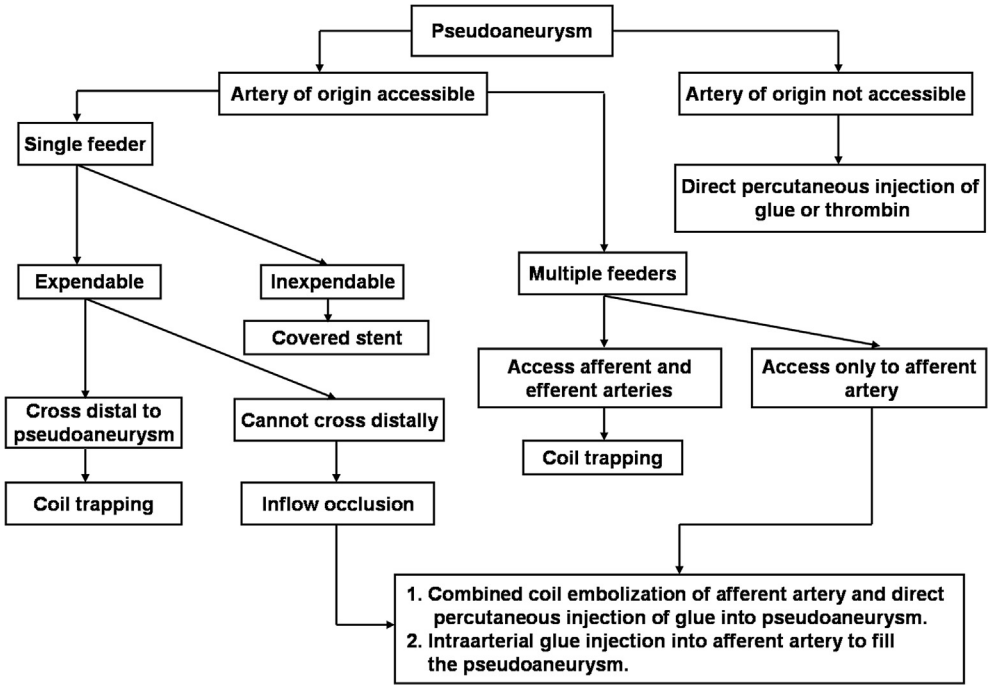

Fig. 9. Algorithm for endovascular management of pancreatitis-related pseudoaneurysms.

safe. Using NBCA to fill the pseudoaneurysm obviates the need to access distal to pseudoaneurysm either by crossing it or gaining access from the SMA. Especially in the pancreatico-duodenal arcade, coiling every arterial supply to the pseudoaneurysm may be difficult. We find that using NBCA reduces the procedure time and thereby the radiation dose to the patient and staff. Compared with the use of multiple coils, NBCA is also less expensive.

Covered stents have been used successfully for isolation of pseudoaneurysm in nonexpendable arteries.[15] The main advantage of using a covered stent is the preservation of flow in the parent vessel (Fig. 7).

Coiling can be combined with either NBCA or gelfoam embolization to complete the treatment. Gelfoam is a safe, temporary embolic agent which can be used in isolation or as an adjuvant to other permanent agents to occlude multiple small efferent vascular branches.[16] A combination of techniques may be employed when isolation is not achieved by a single method (Fig. 8).

Another widely used technique for occluding a pseudoaneurysm is percutaneous direct injection of thrombin into the pseudoaneurysm under ultrasound or fluoroscopy guidance. This is mainly used for pseudoaneurysms not easily accessible via a transcatheter technique and in which the feeding vessel cannot be identified.[17–19] We did not use thrombin in our patients as it is not approved for use in our practice.

Endovascular treatment is effective in the management of pancreatitis-related pseudoaneurysms and has good outcomes. Which endovascular technique to use depends on the vascular location and morphological features of the pseudoaneurysm (Fig. 9). Pseudoaneurysms in the background of chronic pancreatitis tend to have thicker walls compared with pseudoaneurysms in acute pancreatitis. Direct percutaneous or transcatheter NBCA injection is probably safer in pseudoaneurysms with thicker walls. Pseudoaneurysms in the pancreatico-duodenal arcade may require a combination of coiling, NBCA injection, or gelfoam embolization to achieve isolation from circulation.

Conflicts of interest

Authors have no conflict of interest to declare.

Acknowledgement

We would like to acknowledge the invaluable advice and unstinting support of our colleagues in the departments of Medical and Surgical gastroenterology, Amrita Institute of Medical Sciences. This work would not have been possible without the dedication and skill of our radiology technicians and nursing staff.

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